

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of)
)
Possible Revision or Elimination of Rules Under) **Docket No. BO 16-251**
The Regulatory Flexibility Act, 5 U.S.C. Section 610)

To: The Acting Director
Office of Communications Business Opportunities

COMMENTS OF ROBERT BOSCH LLC

Robert Bosch LLC (Bosch), a multinational manufacturer of various high-quality electronic products¹, by counsel and pursuant to the *Public Notice*, 31 FCC Rcd. 13053, DA 16-792 (the Notice), hereby respectfully submits its comments² with respect to the Regulatory Flexibility Act (RFA) review of the Part 15, Subpart F regulations listed at page 5 of the Notice. Bosch urges that the Commission comprehensively review its rules governing Ultra-Wideband (UWB) devices, inasmuch as the failure to do so during the past fifteen years has, and continues to work a significant hardship on small business entities which endeavor to bring new, innovative UWB products to the United States marketplace. It is understood that the purpose of this proceeding is to review rules adopted by the Commission during the years 2001 – 2004 which have, or might have, a significant economic impact on a substantial number of small entities, and to determine whether such rules should be continued without change, or should be amended or rescinded, consistent with the stated objective of section 610 of the RFA, to

¹ Bosch manufactures many different types of products for different industries, including vehicular radar systems and construction tools, worldwide. Bosch has conducted extensive research and development in, and has several products now available and in development using UWB technology. The development of products for use in the United States, however, is substantially inhibited by the preclusive regulatory structure of Subpart F of the Part 15 rules which are and have since their adoption been acknowledged to have been overly conservative.

² Because the Notice in this proceeding was published in the Federal Register on February 3, 2017 (82 Fed. Reg. 9281), these comments are timely filed.

minimize any significant economic impact of such rules upon a substantial number of small entities. The UWB rules listed for review in this proceeding include technical requirements³ for ground penetrating radars and wall imaging systems; through D-wall imaging systems; surveillance systems; indoor UWB systems and hand held UWB systems. However, there are other technical rules applicable to the testing and equipment authorization of all UWB systems that call urgently for re-evaluation at the same time, all of which were adopted in the same Report and Order in 2002. It would not help small business entities engaged in manufacturing UWB products to review only a few of the UWB Part 15 regulations; left unexamined would be UWB technical rules which necessitate, for example, that each and every new UWB product be subject to a rule waiver as an incident of being granted certification for marketing and sale of the device in the United States. There is a well-established and acknowledged need to revisit the UWB technical rules – something the Commission promised fifteen years ago to do but did not do – in order to allow new, useful, innovative and spectrum-efficient UWB products to be brought to the United States marketplace, as they are now in most other countries of the world. Such devices have been shown to have no significant potential to cause interference to incumbent government and non-government radio systems. For its comments, Bosch states as follows:

³ At page 5 of the Notice, there is a list of Part 15 rules to be examined in this proceeding. There is no justification offered for the listing of only a few of the rules adopted in 2002 in the same Report and Order. With respect to UWB devices, the rules to be reviewed in this proceeding include the following:

SUBPART F—ULTRA-WIDEBAND OPERATION

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|--------|--|
| 15.509 | Technical requirements for ground penetrating radars and wall imaging systems. |
| 15.510 | Technical requirements for through D-wall imaging systems. |
| 15.511 | Technical requirements for surveillance systems. |
| 15.517 | Technical requirements for indoor UWB systems. |
| 15.519 | Technical requirements for hand held UWB systems. |

I. Introduction and Background.

1. The Commission has repeatedly stated that its rules governing various types of UWB devices are, generally speaking, overly conservative. In its *First Report and Order*, FCC 02-48, 17 FCC Rcd. 7435 (2002), the Commission, proceeding “cautiously,” established what it referred to as a potentially “overprotective” regulatory scheme for then-nascent UWB technology, which nonetheless was found to offer “significant benefits” for public safety, businesses and consumers:

UWB technology holds great promise for a vast array of new applications that we believe will provide significant benefits for public safety, businesses and consumers. With appropriate technical standards, UWB devices can operate using spectrum occupied by existing radio services without causing interference, thereby permitting scarce spectrum resources to be used more efficiently. This First Report and Order (“Order”) includes standards designed to ensure that existing and planned radio services, particularly safety services, are adequately protected. We are proceeding cautiously in authorizing UWB technology, based in large measure on standards that the National Telecommunications and Information Administration (“NTIA”) found to be necessary to protect against interference to vital federal government operations. These UWB standards will apply to UWB devices operating in shared or in non-government frequency bands, including UWB devices operated by U.S. Government agencies in such bands. We are concerned, however, that the standards we are adopting may be overprotective and could unnecessarily constrain the development of UWB technology. Accordingly, within the next six to twelve months we intend to review the standards for UWB devices and issue a further rule making to explore more flexible technical standards and to address the operation of additional types of UWB operations and technology.

(First Report and Order, 17 FCC Rcd. at 7435)

2. The reason that the Commission proceeded so cautiously in authorizing this then-new technology was that the comments filed in the docket proceeding were somewhat contentious, and the commenting parties were not able to agree on emission levels necessary to protect various radio systems from harmful interference. The Commission therefore was emphatic that the standards contained in the *First Report and Order* were “extremely conservative” and that

they may change in the future as the Commission continued to collect data regarding UWB operations. *Id.*, at 7436. In the intervening fifteen years, however, there have been no documented complaints of interference from UWB devices as far as Bosch has been able to tell, and there are no known residual debates ongoing in technical literature dealing with emission levels. The Commission has quite clearly maintained definitional and eligibility rules that are inconsistent and preclusive during that entire period.

3. By stark contrast, the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Telecommunications Standards Institute (ETSI) have collaborated in Europe during this same period to harmonize UWB regulations worldwide. ETSI has prepared an ITU input document as recently as November of 2016 with worldwide UWB harmonized regulation as a goal.⁴ Furthermore, UWB regulation in the ECC is summarized in ETSI TR 103 181-1 and ETSI TR 103 181-2;⁵ and the currently open discussion within the ECC is premised on some recent studies intended to arrive at appropriate international standards for UWB regulation.⁶

4. In the 2002 *First Report and Order* in the UWB proceeding, beginning at paragraph 122, the Commission analyzed an extensive study by the National Telecommunications Information Administration (NTIA) of the interference potential of UWB terrestrial operation to

⁴ See, ITU-R WP1A/B meeting Nov 2016 input document.

⁵ See, ETSI TR 103 181-1 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB); Transmission characteristics; Part 1: UWB signal characteristics and overview CEPT/ECC and EC regulation" and ETSI TR 103 181-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB); Transmission characteristics; Part 2: UWB mitigation techniques."

⁶ See, ETSI TR 103 416 (V1.1.1): "Short Range Devices (SRD) using Ultra Wide Band (UWB); Transmission and Technical characteristics for SRD equipment using Ultra Wide Band (UWB); System Reference Document for UWB based vehicular access systems;" ETSI TR 103 313 (V1.1.1): "System Reference document (SRdoc); Short Range Devices (SRD) using Ultra Wide Band (UWB); Technical characteristics for SRD equipment using Ultra Wide Band Sensor technology (UWB); Medical, wellness and assisted living applications;" and ETSI TR 103 314 (V1.1.1): "System Reference document (SRdoc); Short Range Devices (SRD) using Ultra Wide Band (UWB); Technical characteristics for SRD equipment using Ultra Wide Band Sensor technology (UWB) based on amended mitigation techniques for UWB."

various government telecommunications and electronic systems. The purpose was to determine appropriate UWB radiated emission levels which could be permitted without causing interference to those systems. The ultimate conclusion was that, because UWB devices would in the worst case create noise-type interference due to increases in the apparent noise floor, the interference potential at the radiated emission levels permitted by the Commission's rules would result in adequate protection for government communications systems from UWB devices. The NTIA study was important in order to determine the proper radiated emission levels from UWBs that would operate in, *inter alia*, the so-called "restricted bands" without a predictable interference potential. However, it was quite clear that the Commission was not satisfied that its rules were sufficiently flexible to permit the development of useful products and systems using this new technology:

We find that there is sufficient information in the record to make initial decisions at this time that provide for the introduction of UWB technology based on standards that are extremely conservative in protecting radio services against harmful interference. We recognize, however, that as this technology develops and we gain experience with the potential interference of UWB devices, it is appropriate to reexamine these rules. Accordingly, within the next six to twelve months we intend to review the standards for UWB devices and issue a further rule making to explore more flexible technical standards and to address the operation of additional types of UWB operations and technology.

(First Report and Order, 17 FCC Rcd. at 7525)

The Commission did in fact peripherally revisit the UWB rules in a *Second Report and Order and Second Memorandum Opinion and Order*, (*Second R&O*), FCC 04-285, 19 FCC Rcd. 24558 (released December 16, 2004). The stated purpose of the *Second R&O* was to "amend Part 15 of [the] rules to provide greater flexibility for the introduction of new wide-bandwidth devices and systems." However, there was not any amendment of the specific rules applicable to UWB devices, but instead, only the amendment of the general Part 15 rules. The Commission again

expressed reluctance to “change the existing UWB rules until we have more experience with UWB devices (footnote omitted). We continue to believe that any major changes to the rules for existing UWB product categories at this early stage would be disruptive to current industry product development efforts.” *Id.*, 19 FCC Rcd. at 24560. Thus, the Second R&O merely adopted rules dealing with wide-bandwidth part 15 devices.

5. There has not, in fact, been any significant review of any of the UWB rules since the adoption of the *Report and Order* in Docket 98-153 in 2002. Bosch does not dispute that the Commission properly, in a somewhat controversial rulemaking proceeding, proceeded cautiously and conservatively in adopting initial rules which it intended to: (1) encourage the development of new UWB applications, while at the same time (2) clearly protect, *ex ante*, incumbent licensed and government radio services against interference. However, it has now been fifteen years since the adoption of what have proven to be inherently confusing and overly restrictive UWB rules which have stifled manufacturing and the availability of UWB products which are in successful use outside the United States, and there has never been any revisiting of those rules as the Commission promised to do. As far as Bosch can determine, there are no documented instances of interference from any UWB device to a licensed radio service. The rules, however, have clearly created a significant obstacle to the implementation by Bosch and many other business entities of useful UWB technology which can enhance and facilitate building and construction efforts substantially; assist in assessing and repairing deteriorating infrastructure in the United States; and save costs, money and time, without any substantial interference potential. The Commission’s rules, which the Commission expressly labeled “overprotective,” are under any circumstances hostile to small and medium manufacturers and beg for re-evaluation now.

II. Virtually All UWB Devices Require Waivers in Order to Obtain Grants of Equipment Authorization Under the Current Rules Structure.

6. Perhaps the most glaring evidence of the need to revisit UWB technical rules now is the large number of waivers that have been issued regularly in order to bring a UWB device to the United States marketplace. It is apparent that the Commission is in the inefficient position of having to regulate UWB in the United States largely by waiver rather than by revisiting and replacing the current, conservative and limiting rules now in place with those that facilitate the technology while protecting incumbent services from interference. Virtually all UWB devices approved for marketing and sale in the United States to date have been pursuant to *rule waivers*. The disadvantages of regulating by waiver include (1) delays in getting a product to market (typically 19-24 months); high legal and engineering expenses for manufacturers; unpredictability as to outcome; and an arbitrary, and somewhat inconsistent series of permitted and non-permitted devices. A product should not be permitted or prohibited based on whether or not the manufacturer can suffer the risk, delay and expense of a rule waiver proceeding each time it has a new or even a modified UWB device. This discriminates unreasonably against small business entities which cannot suffer the risks, costs and delays of the waiver proceedings in order to get their products to the marketplace. An overhaul of the UWB rules that eliminates unnecessary restrictions and distinctions, and authorizes any UWB device that presents no realistic threat of interference, would be far better from the perspective of the regulated manufacturing industry as a whole and for small businesses especially who cannot otherwise produce competing UWB products; as well as for the small businesses in the industries that would benefit from having the products.

(A) The Time Domain, U.S. Radar and Zircon Waivers – 1999.

7. On July 8, 1999, prior to the 2002 Report and Order that adopted the present UWB rules for the first time, the Office of Engineering and Technology, on delegated authority, granted waivers of certain Part 15 rules to three companies: Time Domain Corporation; U.S. Radar Inc.; and Zircon Corporation. These waivers allowed the limited marketing of UWB devices, subject to certain conditions. The Commission's premise was that UWB technology had unique attributes that could lead to a variety of new, beneficial uses that would serve the public interest. The conditional waivers granted to Time Domain, U.S. Radar and Zircon would, the Commission said, help in assessing the impact of UWB devices on the RF environment prior to adoption of FCC rules permitting some UWB operation. The waiver granted to U.S. Radar allowed it to market a radar system to detect buried objects such as plastic gas pipes or reveal hidden flaws in roads, bridges, or airport runways. The waiver granted to Time Domain allowed it to supply police departments with a communications system that would provide law enforcement officers with a means of covert communication and to provide radar systems that would enable fire and rescue personnel to determine the location of persons inside damaged, burning, or smoke filled buildings. Zircon's waiver allowed it to supply a radar system that was capable of detecting objects, such as electrical wiring conduit, water pipes, and gas lines, behind walls and other surfaces. The three waivers, for different applications, were granted together.

8. Because the bands used by these devices included several frequency bands allocated to the U.S. Government, these waiver requests were coordinated with the National Telecommunications and Information Administration (NTIA). NTIA informed the Commission, by letter dated June 15, 1999 that the waivers could be granted with conditions that, among other things, limited distribution of the devices and required that records be maintained for all users to whom the three companies sell, lease or otherwise distribute UWB equipment. NTIA required

that the equipment to be sold by each company be certified under the equipment authorization process. If harmful interference was caused or if the FCC adopted rules prohibiting them, then the company was to stop manufacturing or selling the products. All sales had to be documented so as to permit recovery of the devices sold later in case of interference. Special procedures were stated for coordination of channel use. Operation of the devices was generally prohibited near airports, GPS facilities or SARSAT, NOAA or radioastronomy facilities. All devices required manual operation through proximity switches, etc., and no aeronautical operation was permitted. There were waiver conditions specific to the devices as well. For the U.S. Radar waiver, the term was four years, during which the applicant could market and sell its SPRscan GPR product. The limit on sales per year was 25 for this device. The signal had to be directed toward the ground at all times, and the waveform peak to average ratio was 30 dB. For the Time Domain device, the same 4-year term was as specified, but all told, 2500 units could be sold each year of the waiver period. Eligibles were limited to police and fire departments and users of Part 90 public safety frequencies. The device waveform peak-to-average ratio was limited to 23 dB for communications systems and 26 dB for radar systems. For the Zircon device, the Commission allowed the marketing of 5000 systems used for through-wall imaging radar systems in construction environments provided that they meet certain average field strength limits. For example, on frequencies above 1 GHz, the limit was 63 microvolts per meter average at 3 meters, measured in 1 MHz. For bands between 960 MHz and 1 GHz, the limit was 63 microvolts per meter quasi-peak at 3 meters, measured in 100 kHz. The device waveform was 23 dB.

9. The Commission rules that were waived at the time, prior to the adoption of the UWB rules in Part 15, were Section 15.205(a), which specifies that only spurious emissions may be

placed in certain designated restricted frequency bands of operation; and Sections 15.31 and 15.35 which require the application of a pulse desensitization correction factor when performing certain measurements below 1000 MHz. In announcing the grant of the waivers, the Commission said that the three waivers in no way prejudged any action that the Commission may take regarding UWB devices in the then-pending ET Docket 98-153. Nor should they be deemed in any way to prejudice NTIA's consideration of the issues involving the operation of UWB devices in any inquiry or rule making proceeding undertaken by the FCC. In this regard, NTIA requested that additional waivers to permit the marketing of UWB devices that emit radio frequency energy in the U.S. Government restricted bands be *extremely limited* until further analyses and measurements were completed and a regulatory framework developed.

(B) The Post-Docket 98-153 Waivers

10. After The Commission issued the UWB rules in February of 2002, it issued an Order (DA 02-1658, released July 12, 2002 in Docket 98-153) granting a “blanket waiver” to the manufacturers of existing GPR and wall-imaging products authorized by experimental license or waiver prior to July 15, 2002 so as to permit prior users of those devices to keep using them. This was based, said the Commission, on the absence of reported harmful interference, and because of the public safety benefits resulting from the use of GPRs and wall imaging systems. The blanket waiver, however, was limited to *those two types of UWB device*. It refused to afford the same blanket waiver to UWB surveillance systems, through-wall imaging devices or medical imaging systems because of a lack of experience with them. The same order encouraged those entities which felt disenfranchised by the UWB rules, including GPR or wall imaging device manufacturers, to seek waivers.

11. The conditions under which GPR and wall imaging manufacturers were entitled to the blanket waiver included the following:

The operator shall follow the coordination procedures specified in 47 C.F.R. § 15.525. Coordination of each individual usage is not required. Instead, the coordination information shall describe the general areas in which the equipment is to be operated. This could consist of the count(y)(ies) of operation or even the state(s) of operation. We expect NTIA to notify the operator, through us, of any critical locations within these areas, as described in 47 C.F.R. § 15.525(e). Subsequent changes in operational areas will require the filing of a new transmission location following the procedures in 47 C.F.R. § 15.525 but will not affect the waiver status of the equipment described in the prior submission.

In lieu of an FCC ID number, the users of GPRs and wall imaging systems purchased before July 15, 2002, shall provide us with a description of their equipment when filing for coordination. That description shall include, as a minimum, all identifying nomenclature on the product, such as the brand name and model, along with the frequency at which the GPR or wall imaging system operates. To the extent they are available, the operator shall provide emission characteristics described in 47 C.F.R. Part 15 Subpart F, as based on the measurement procedures described in the *Order*. We are not requiring equipment operators to have these emission characteristics measured. However, these emission characteristics may be used to calculate safety zones in the coordination process and, if not available, may result in increased safety zone areas.

The operator shall supply the purchase date of the GPR or wall imaging system. An approximate date is acceptable if an exact date is not available. The GPR or wall imaging system must have been purchased by the operator prior to July 15, 2002, the effective date of the new UWB regulations, in order to qualify under this registration and waiver provision.

As far as can be determined, this blanket waiver is still in effect and these procedures are still followed for GPR and wall imaging systems, but NOT for through-wall imaging systems.

(C) Multiband OFDM Alliance Waiver

12. In June 2002, a UWB start-up, XtremeSpectrum, introduced the first UWB device under the new rules for wireless connectivity applications using its direct sequence-UWB (DS-UWB) technology. XtremeSpectrum was acquired by Motorola in 2003 and later became the Ultra-Wideband operation of Freescale Semiconductor. In 2004, Freescale received FCC certification for the first UWB device for wireless communications applications under the UWB

rules. The 110 Mbps device was manufactured and made commercially available. However, at the time of the FCC UWB Report and Order in 2002, Multiband Orthogonal Frequency Division Multiplexing (MB-OFDM) had not been developed. In 2004, the Multiband OFDM Alliance filed a waiver request to allow this UWB application to be measured using different procedures than were specifically stated in the 2002 rules.

13. Under the original rules, UWB devices were required to be tested under full power, even if the devices themselves had “gating” or power-saving technology built in. MB-OFDM is a frequency-hopping technology, and therefore turns on and off frequently. The frequent bursts of power required to hop from one band to another exceed the -41 dBm/MHz power limit when measured in an always-on fashion. MB-OFDM specifications showed that this technology hopped an average of three times in a given transmission cycle, compromising performance when it tried to meet the FCC emission testing. The waiver request asked that the measurement for compliance be done only for the actual time transmitting, not the aggregate power of an always-on system.

DS-UWB was also subject to the always-on requirements for measurement. However, because DS-UWB transmits longer, continuous signals, it easily met the emission criteria while still delivering 110 Mbps at a range of 10 meters.

14. The Commission granted the MBOA waiver in March of 2005. In its *Order*, the Commission said that it was waiving the existing measurement procedure, permitting emissions from UWB transmitters to be determined with the transmitter operating “normally.” The Commission concluded that this would not result in increased harmful interference to licensed radio operations. *This waiver applied only to indoor or handheld UWB devices.* Further, UWB devices utilizing this waiver could not operate within the 5030-5650 MHz band used for aircraft

landing systems and for weather radars. A decision to permit this waiver to apply to UWB devices that operate within the 5030-5650 MHz band was to be made upon the completion of the interference investigation performed by the Institute for Telecommunication Sciences. The waiver was said to be effective until the Commission finalizes a rulemaking proceeding dealing with the UWB measurement issues. The grant of this UWB waiver effectively removed the previous transmit power penalties for both frequency-hopping and gated UWB technologies. However, the ability of different UWB technologies to benefit from the new waiver provisions still depended greatly on a system design that can both leverage the benefits of UWB operation and effectively use gating or hopping to improve system performance. Under the rules, the -41 dBm/MHz power level had to be measured in always-on mode. After the waiver, only average power had to be measured; systems were then allowed to burst and then sit quiet when measuring the -41 dBm/MHz power limit.

15. Thus, FCC allowed measurements to account for the time averaging during the time period in which the UWB emitter is not transmitting. In reaching its decision, the Commission recognized that the interference aspects of a transmitter employing frequency hopping, stepped frequency modulation, or gating are quite similar, as viewed by a receiver, in that transmitters using these burst formats appear to the receiver to emit for a short period of time followed by a quiet period. The FCC concluded that any requirement to stop the frequency hopping, band sequencing, or system gating serves only to add another unnecessary level of limitations to already overly strict UWB standards.

(D) UltraVision Security Systems, Inc. Waiver

16. On November 20, 2008, FCC granted in part a request submitted by UltraVision Security Systems, Inc. (UltraVision) for a waiver of the UWB rules to allow limited marketing of

its UltraSensor UWB surveillance systems. UltraSensor is a UWB fixed radar surveillance system designed to operate in the spectrum region below 960 MHz, from 80 MHz to 600 MHz, and is intended to provide warning of intruders to sites with strategic or commercial interests. Each system consists of six to ten unlicensed transmitters buried 15-20 centimeters (6-8 inches) underground, below pavement or lawn turf, about every 20 meters (65 feet) around the site to be protected. The system tracks the location, velocity and mass of an intruder and can be programmed to ignore small animals, *e.g.*, birds and dogs, to respond only to pedestrians and vehicles, or to respond only to vehicles above a certain size or speed.

17. This was initiated in 2006 and resulted in a Docket proceeding (06-195). UltraVision requested a waiver of the permitted operating frequency range and permitted users in Sections 15.511(a) and (b) of the rules to allow it to market up to 350 installations of the UltraSensor system over a two year period. Section 15.511(a) requires the bandwidth of a UWB surveillance system to be contained between 1990 and 10,600 MHz. Section 15.511(b) limits the sale and operation of UWB surveillance systems to law enforcement, fire or emergency rescue organizations or manufacturing, petroleum or power licensees as defined in Part 90 of the Commission's rules. FCC agreed to waive those rules to permit the UltraSensor surveillance system to operate in the 80-600 MHz frequency band and to allow UltraVision to market the systems to any entity eligible for licensing under Part 90 of the rules. It did, however, impose specific operational and technical conditions on the UltraSensor systems to ensure that authorized spectrum users are protected from harmful interference, including maintaining the requirement that operators of these surveillance systems comply with the Commission's coordination requirement for ultra-wideband devices in Section 15.511(b)(2). FCC denied that part of UltraVision's request which asked that UltraVision be allowed to maintain a list of

installations in lieu of complying with the prior coordination requirements. The waiver was found to be in the public interest because it would permit the operation of systems capable of providing protection from undesired intrusions to secured facilities, without increasing the risk of harmful interference to authorized services.

(E) Robert Bosch Wallscanner Waiver

18. In November of 2010, Bosch applied for a waiver of Section 15.503(h) of the FCC's rules for its Wallscanner D-tect 150 Professional device and for functionally identical versions of that device, in order to permit Bosch to import and market the device upon receiving a grant of equipment authorization. This waiver was granted in May of 2011, six months after applying for the waiver. The waiver was conditioned on compliance with all other requirements of the Commission's rules, including the technical and operational requirements for unlicensed ultra-wideband imaging systems in Section 15.509 of the Rules. Grant of the waiver was due to useful applications in building construction, as well as inspection and maintenance of buildings in the United States, and the finding that it would have minimal interference potential due to its non-consumer product character. The fact that the wallscanner device was already in widespread use in Europe, Canada, and Asia and the fact that it met all technical requirements of the Commission's Part 15 rules applicable to UWB devices were cited as important factors.

19. The waiver was merely one of definition: Section 15.503(h) of the Rules defines a "wall imaging system" as a "field disturbance sensor that is designed to detect the location of objects ... or to determine the physical properties within the 'wall' [which is a] physical structure that is dense enough and thick enough to absorb the majority of the signal transmitted by the imaging system." The rule excludes "products such as 'stud locators' that are designed to locate

objects behind... walls that are not capable of absorbing the transmitted signal.” Bosch candidly noted that not every wall or other structure scanned by the Wallscanner would be dense and thick enough to absorb the entirety of the transmitted radio signal; therefore, the Wallscanner would not necessarily meet that part of the definition. Furthermore, the Wallscanner included as one of its operating modes a “stud locator” function which would preclude its classification as a wall imaging system. Had the Wallscanner been classified as a “through-wall imaging system,” its intended use would not comply with Section 15.510(b) of FCC rules, which restricts the use of such systems to law enforcement, emergency rescue or fire-fighting organizations that are under the authority of a local or state government, thus limiting the application of through-wall imaging systems to public safety functions. Ultimately, because the Wallscanner was not a consumer device and because it would operate well below the maximum radiated emission level in Section 15.509, which is an EIRP of -41.3 dBm/MHz in the band 3,100-10,600 MHz, the waiver was found to be acceptable. Since that time, however, successor versions of the device would have been subject to a repeat of the waiver request process.

(F) Curtiss-Wright Controls Inc. – GPR Device Waiver

20. In January of 2012, the Commission granted a waiver to Curtiss-Wright Controls Inc. of Sections 15.503(d) and 15.521(d) of the UWB rules for its ground penetrating radar System called “3d-Radar.” Curtiss-Wright had requested this waiver in June of 2010, a year and a half before. This GPR device detects buried objects, changes in material, and cracks in ground or in other subsurface structures and are typically used in the maintenance of highways and bridge infrastructures in the United States. This too was in effect a definitional waiver. Section 15.503(d) of the Rules specifies the minimum operational bandwidth of an UWB transmitter. The measurement procedure for determining minimum bandwidth for UWB devices is Section

15.521(d). The waiver required grant of equipment authorization for this GPR and compliance with all other technical and operational requirements for unlicensed UWB GPR devices. Like the Wallscanner, the device was found to be useful for improvement of the safety of transportation infrastructure without increasing the potential for interference to authorized radio services.

21. The definition of a UWB device is one which has a fractional bandwidth equal to or greater than 0.20 or an UWB bandwidth equal to or greater than 500 megahertz, regardless of the fractional bandwidth. Clearly, the rules envision that UWB devices employ pulse modulation technologies. When it adopted the UWB rules, the Commission said that UWB devices could use other modulation types *if they meet the minimum bandwidth requirements* and that this requirement was intended to avoid having devices designed for the “restricted bands” if they did not need to operate in those bands. The Commission also said that “it was unlikely” that swept frequency, stepped frequency, or frequency hopping systems would comply with the minimum bandwidth requirement because, unlike UWB systems, the emissions for these other systems were typically measured with the sweep/step/hopping function stopped. Section 15.521(d) of the Commission’s rules sets forth the measurement procedures for UWB devices to demonstrate compliance with applicable emission limits. For emissions above 960 MHz, this rule requires that, if pulse gating is used and the transmitter is stopped for longer intervals than the nominal pulse repetition interval, measurements are made with the pulse train gated on. The Commission said it would also “consider alternate measurement procedures.” Clearly, this signaled an intention to use a waiver procedure for authorizing, if not all, then the vast majority of UWB device. Curtiss-Wright said that its 3D-Radar system operated between 140 MHz and 3 GHz using stepped frequency modulation to achieve performance characteristics of deep signal penetration, high resolution imaging, and fast survey speeds.

22. The 3D-Radar uses an array of closely spaced antennas that transmit sequentially over a wide band of spectrum and gathers a variety of data from underground structures in a single pass. The system transmits over 1,431 frequencies in 2-megahertz steps between 140 MHz and 3 GHz with a scan/cycle rate of approximately 2.86 milliseconds. Its stepped-frequency technique using a wide bandwidth antenna array allows it to travel at high speeds and eliminate the need for multiple passes. This results in less RF energy being transmitted at any one location, thereby minimizing risk of potential interference to authorized services. The fact that it had already been certified for use in the European Union was a large factor in the waiver grant decision. Because the 3D-Radar system did not satisfy the definitional requirement of Section 15.503(d) that an UWB transmitter “at any point in time” has a fractional bandwidth equal to or greater than 0.20 or has an UWB bandwidth equal to or greater than 500 megahertz, a waiver was necessary. It also required a waiver of the Section 15.521(d) measurement procedure requirement that if pulse gating is used and the transmitter is quiescent for longer intervals than the nominal pulse repetition interval, measurements are made with the pulse train gated on. There were supporting comments filed by Bosch and by the Federal Railroad Administration, but opposition from the GPS Industry Council, concerned about interference. NTIA had already approved the device for use by the U.S. Department of Transportation. There was a discussion about notching of frequencies but Curtiss-Wright said that a notching requirement would create unclear images and the Commission’s rules did not require such. Although the device used stepped frequency modulation, the Commission was persuaded that this device was similar in all other respects to normal GPRs and that most of the energy would be radiated into the ground. The Commission noted the complete absence of interference complaints from GPRs authorized by blanket waivers or experimental authorizations. Furthermore, it was found to be a useful tool for monitoring

transportation, and especially railroad, infrastructure and insuring safety of travel. The waiver in this case was granted subject to the following conditions:

- It must be certified by the Commission, and operate with stepped frequency modulation in 2 megahertz steps between 140 MHz and 3 GHz with a scan/cycle rate of approximately 3 milliseconds. The system may not use any single frequency longer than 2 microseconds in any 3 millisecond period of time.
- Measurements of emissions must be conducted with the stepping function active.
- The device cannot be sold in any hand-held configuration.
- It must comply with all other technical and operational requirements applicable to UWB GPR devices under Part 15, Subpart F of the Commission's rules.
- It must implement frequency notching to avoid placing intentional transmissions in the bands 608-614 MHz, 1400-1427 MHz, 1660.5-1668.4 MHz, and 2690-2700 MHz.

The Commission, in 2013, modified the above waiver conditions at Curtiss-Wright's request, so as to permit use of stepped frequency modulation in 2, 10, or 20 megahertz steps, and by changing the original pulse width requirements to a duty cycle requirement.

(G) Autoliv ASP, Inc. and Caterpillar, Inc. – UWB Vehicular Radar Waiver

23. On December 30, 2013 FCC granted a temporary waiver of the UWB emissions limits in Section 15.515(c) of the FCC's rules. This waiver permitted Autoliv to continue to manufacture and market to Caterpillar until December 31, 2014 and for Caterpillar to import until that same date Autoliv's C4 vehicular radars. These radars comply with the existing emissions limits of Section 15.515(c), but did not comply with the limits that were phased in on January 1, 2014 under that same rule. The Commission granted the waiver to permit the continued use of Caterpillar vehicles, which can't be operated safely without effective radar systems, due to their size and shape and their operating environment (often in mines and in narrow passageways). Accordingly, Caterpillar needed a temporary waiver in order to continue to equip the subject vehicles with the C4 radar systems through 2014, after which systems using

compliant radars became available from Autoliv. About the emission limits, the Commission said that they have evolved over time, with one standard applicable to equipment manufactured after January 1, 2005, another standard applicable to equipment manufactured after January 1, 2010, and yet another standard applicable to equipment manufactured after January 1, 2014. FCC's principal concern in adopting this rule and set of phased-in limits was the cumulative interference to passive sensing systems operating in the 23.6 to 24.0 GHz band on low earth orbiting satellites, including meteorological satellites, caused by "potentially tens of thousands of transportation vehicles employing these radar devices." Multiple factors, most notably the low density of vehicles, led the Commission to conclude that the impact of this waiver on the potentially affected satellites is likely to be negligible.

(H) Conclusions.

24. The Commission's failure to make any permanent modifications to the UWB rules, or even to propose such over a fifteen-year period, necessitated a continuous series of waivers for such products. These were sought at great expense to the importers and manufacturers of such devices, and the procedure has resulted in substantial delays in bringing new UWB devices to the marketplace. The obligation has ill-served the consumers and users of such devices and the ability of small business entities to compete in the development and marketing of UWB products in the United States. They are unwilling to invest in the research and development necessary to bring new products to the marketplace because of the risk in doing so that the devices won't be approved. Regulation by waiver is an inadequate substitute for flexible rules which should permit many UWB products to become certified for marketing and sale in the United States as a matter of course. No such rule changes are currently proposed. The Commission is willing to grant waivers on an irregular basis, but that procedure involves placing them on a public notice, taking

public comment in response to them, and then staff analysis of the waiver request, often in consultation with NTIA. This process takes well more than a year in many cases. Given the expense and delay and the relatively short life cycle of manufactured electronic products, few UWB devices are available here. By contrast, large numbers of such products are in successful use in Europe and Asia and interference potential is successfully managed through flexible rules which are under regular review.

III. Rule Changes Suggested Herein Will Reduce “Regulation by Waiver” for UWB Products and Permit Effective Competition in the United States by Small Business Entities Without Increasing Interference Potential to Authorized Radio Services.

(A) Definition of Minimum Bandwidth

25. Principal among the UWB rules necessary for modification are the 2002 rules governing UWB minimum bandwidth. The Commission had earlier proposed to define a UWB device as any device where the fractional bandwidth is greater than 0.25 or occupies 1.5 GHz or more of spectrum.⁷ The formula proposed for calculating fractional bandwidth was $2(f_H - f_L)/(f_H + f_L)$ where f_H is the upper frequency of the –10 dB emission point and f_L is the lower frequency of the –10 dB emission point. The center frequency of the transmission was defined as the average of the upper and lower –10 dB points, i.e., $(f_H + f_L)/2$. The Commission proposed to base its modified definition of an UWB device on –10 dB bandwidth.

26. Those who filed comments typically urged that the definition of UWB should either be a fractional bandwidth or a minimum emission bandwidth.⁸ There was no consensus, however, on the specific values that should be applied for a device to be defined as UWB. The comments also disagreed about limiting the modulation to pulsed modulation, and requiring that

⁷ Under the proposed definition of an UWB device, the 1.5 GHz maximum bandwidth limit would only apply where the center frequency is greater than 6 GHz.

⁸ The Commission uses the term “minimum bandwidth” to refer to the bandwidth above which a product qualifies as a UWB device regardless of its fractional bandwidth.

the bandwidth be directly related to the narrow pulse width instead of the data rate. Bosch's position was that the definition of UWB should be based solely on bandwidth using the –10 dB emission points. Bosch stated that the –20 dB emission points were too near the noise floor to be measured reliably. Bosch also noted that the –20 dB emission points would be ambiguous, as such points appear on both the fundamental lobe and the side lobes. Bosch argued that basing the definition of UWB on the use of a narrow pulse width to achieve a wide emission bandwidth could impede the development of novel pulse or modulation schemes, including high-speed data systems.

27. In the 2002 *First Report and Order* in the docket proceeding, the Commission decided to use the –10 dB emission points to determine the bandwidth and the center frequency of the UWB emission. It agreed with Bosch and others that the –20 dB emission points could be so near the noise floor that making accurate measurements would be difficult or impractical. It also decided that the minimum required fractional bandwidth should be reduced given that the use of the –10 dB bandwidth measurement points will result in a smaller measured bandwidth. So the Commission decided that the –10 dB fractional bandwidth should be 0.20, and that the minimum bandwidth limit, originally proposed to be 1.5 gigahertz, would instead be 500 megahertz for UWB devices.⁹ FCC said that the minimum bandwidth limit of 500 megahertz should accommodate “most of the proponents in this proceeding.” FCC specifically refused to eliminate all restrictions on fractional bandwidth and minimum bandwidth, because without the limit, devices could be designed to operate in restricted bands without any need to do so.

⁹ As noted, UWB devices would be required to have a –10 dB fractional bandwidth of at least 0.20 or a –10 dB bandwidth of at least 500 MHz. The effect of this change is that UWB systems with a center frequency greater than 2.5 GHz need to have a –10 dB bandwidth of at least 500 megahertz while UWB systems operating with a center frequency below 2.5 GHz need to have a fractional bandwidth of at least 0.20.

28. The Commission agreed with Bosch that transmission systems should not be precluded from the UWB definition simply because the bandwidth of the emission is due to a high speed data rate instead of the width of the pulse or impulse. Therefore, the Commission noted, *“as long as the transmission system complies with the fractional bandwidth or minimum bandwidth requirements at all times during its transmission, we agree that it should be permitted to operate under the UWB regulations.”* This requirement, that the minimum bandwidth must be met “at all times,” precludes the use of essentially all modulation schemes, except a continuous-wave signal of at least 500 MHz bandwidth. Pulsed emissions, frequency-hopping emissions, and swept frequency (*e.g.*, FMCW), stepped frequency systems are all, strictly speaking, precluded by this requirement.

29. Nevertheless, the definition of UWB relative to minimum bandwidth requirements adopted in the UWB *First Report and Order* is unchanged to the present time. It reads as follows:

Section 15.503 Definitions.

- (a) UWB Bandwidth. For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L . The frequency at which the highest radiated emission occurs is designated f_M .
- (b) Center frequency. The center frequency, f_C , equals $(f_H + f_L)/2$.
- (c) Fractional bandwidth. The fractional bandwidth equals $2(f_H - f_L)/(f_H + f_L)$.
- (d) Ultra-wideband (UWB) transmitter. An intentional radiator that, **at any point in time**, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

(emphasis added)

The rule requires, without exception, therefore, that the minimum bandwidth requirement must be achieved at all times during the transmission, regardless of modulation or emission type. Apparently, current measurement procedures require that measurements of swept frequency devices be made with the frequency sweep stopped.¹⁰ The sweep is stopped because no measurement procedures have been proposed or established for swept frequency devices nor have the interference aspects of swept frequency devices been evaluated based on the different measurement results that would be obtained from measurements taken with the sweep active. Similarly, measurements on a stepped frequency or frequency hopping modulated system are performed with the stepping sequence or frequency hop stopped. With the sweep, step function or hopping stopped, it is unlikely that swept frequency (linear FM or FMCW) or stepped frequency modulated emissions would comply with the fractional bandwidth or minimum bandwidth requirements. The Commission admitted that it is “unlikely that frequency hopping systems would comply unless an extremely wide bandwidth hopping channel is employed.”

30. In 2003, the Commission issued a *Memorandum Opinion and Order and Further Notice of Proposed Rule Making* in the UWB docket, which made no change in the minimum bandwidth requirement but did state: “The rules adopted in the *R&O* also permit UWB devices to comply with the minimum bandwidth requirement due to the use of a high speed data rate or the use of other modulation techniques instead of the width of the pulse or impulse signal.

31. Finally, in December of 2004, the Commission issued a *Second Report and Order and Second Memorandum Opinion and Order*, which addressed proposed changes in operational standards for unlicensed devices that may apply simply due to the bandwidth of the transmission system. The Commission said that its standards for unlicensed devices must reflect emission limits that reduce the potential for causing harmful interference to authorized radio services. The

¹⁰ 47 C.F.R. §15.31(c).

emission limits applied to UWB ensure a low probability of causing harmful interference, *and the minimum bandwidth requirement could have the opposite effect than what is intended: it could cause a manufacturer to design transmitters that occupy more bandwidth than is operationally necessary or transmitters that inject noise in order to increase the occupied bandwidth simply to permit operation under the UWB regulations. This would place greater energy in frequency bands where operation is not necessary for the system to function and increase the interference potential.* So, the Commission realized that a minimum bandwidth standard could be counterproductive to reducing the potential for harmful interference and it proposed to eliminate the definition of an ultra-wideband transmitter in 47 C.F.R. § 15.503(d). The Commission recognized that it is the limit on emission levels (and particularly the limit on spectral power density) that primarily controls interference potential, not whether or not the minimum bandwidth is met “at all times.” The Commission proposed to permit the operation of any transmission system, regardless of its bandwidth, as long as it complies with the standards for UWB operation set forth in Subpart F of 47 C.F.R. Part 15 and based the resolution bandwidth used for the peak power measurement to 10 percent of the -10 dB bandwidth of the emission. NTIA opposed eliminating the bandwidth requirements, stating that the supporting comments offer no technical support and expressing concern that such a change would permit operation in the restricted bands regardless of the bandwidth of the unlicensed emission.

32. There were petitioners for eliminating the minimum bandwidth requirement. The Commission accommodated them by amending the Part 15 rules applicable to peak power levels for unlicensed operation in the 5925-7250 MHz, 16.2-17.7 GHz and 22.0-29.0 GHz bands. However, the Commission said it found “no necessity at this time to eliminate the UWB minimum bandwidth requirements.” It said that such changes “could be disruptive and could

further delay the introduction of UWB devices” and that any operation in the restricted bands should be subject to the additional technical standards and operational parameters specified in the UWB regulations. So, it refused to change the minimum bandwidth requirements for UWB devices “until additional experience has been gained with this equipment.”

33. It would appear that the Commission recognized that its requirement that the minimum bandwidth of a UWB device must be achieved “at all times” during a transmission would impose limits on UWB deployment and preclude certain UWB products. What perhaps it did not realize was that the requirement, if strictly interpreted, would prohibit effectively all UWB devices, since none, including pulsed emission UWB devices, can meet this absolute restriction absent a waiver grant. The Commission’s motive was clear: it was proceeding cautiously and intended at all costs to avoid interference in the Part 15 restricted bands. The rule, however, is unclear, and is completely preclusive, because a common-sense interpretation to it has not heretofore applied: that “at any point in time” means “at any point in time in its normal operating mode.” Absent such an interpretation, any UWB product that would not, at all times during its transmit cycle, meet the minimum bandwidth requirement would require a waiver from the Commission, as would any other type of UWB device. It is not reasonable to continue to preclude all frequency hopping UWB emissions below 10 GHz, nor all pulsed and swept emissions. The definitional limitation should be modified.

(b) The Definitions of “Imaging System” and “Surveillance System” Should Be Broadened and Additional UWB Applications Permitted.

34. Section 15.503(e) narrowly defines “imaging systems.” Bosch suggests that the term should include material sensing devices more generically. To avoid interference to other users it is possible to change the existing test environment for ground probing devices which is now sand pitch to a generic test scenario in which UWB material sensors are radiated into the material to

be evaluated. For the conformance test the emissions outside this scenario should be measured. To describe such test methodologies, the Commission is properly referred to ETSI harmonized EN 302 065-4.¹¹ Surveillance systems could be interpreted as providing a radio determination function such as the detection of objects in free space. ITU-R RR: 1.9 defines radiodetermination as the determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.

35. The uses of the benefits of UWB are far wider than the limited definitions in the current rules permit. System possibilities include ranging, tracking, object classification, and low power consumption. The benefits of more flexible use cases can be realized with low regulatory impacts. UWB devices utilize very low radiation levels, low power spectral density, and high levels of spectrum sharing through overlays and the availability of numerous mitigation techniques such as limited duty cycles, limited radiation patterns and beam tilt requirements. UWB outdoor (mobile and fixed) applications for surveillance should be available generically, but with necessary interference mitigation restrictions. This point is currently under discussion in the ECC as well.¹² The following example outlines one possible application: Motion and presence detection in the field of home and building automation is a fast growing application sector. Current technologies like passive infrared or continuous wave radar sensors have different drawbacks such as sensitive lenses, coarse recognition qualities or temperature dependencies. Ultra-wideband sensors can combine the advantages of different sensor technologies. These can be invisible, mounted behind non-metallic covers, allowing higher

¹¹ ETSI EN 302 065-4: "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 4: Material Sensing devices using UWB technology below 10,6 GHz".

¹² See ETSI TR 103 314

precision detection and distance measurements of moving objects. Such features make an UWB sensor outstanding for outdoor motion and presence detection. The basic technical requirements of this application include (a) Bandwidths up to 2.5 GHz within the 6 to 9 GHz range; Use of pulse-based sensors with a PRF of $\leq 4\text{MHz}$; the UWB signal would be mean power limited; it would provide location precision of 0.1 to 1 meter (in distance and object separation); a detection distance of between 15-18 meters; A low duty cycle (LDC) parameter typically $< 1\%$ (single transmission, T on-time: $\sim 2\text{ns}$); an antenna gain of $< 4\text{dBi}$; 90 degree horizontal and vertical pattern; an antenna tilted down from the horizon, with an installation height of between 2-3 meters; and this would allow motion detection active 24 hours per day with no appreciable interference potential at all.

36. For motion and presence detection applications, mitigation factors could be required: duty cycle restrictions, such as $< 1\%$ with a transmission template (e.g. transmit on times of 2-5 nanoseconds; power restrictions for fixed applications such as -51.3 dBm/MHz (this is a typical level that could be assumed to be radiated through the walls from indoor applications; 10dB is used in CEPT/ECC studies for indoor/outdoor effects); field strength limits over the horizon, assuming, for example, an installation height for fixed applications of $> 10\text{ meters AGL}$; antenna angle limits requiring down tilt; and as necessary, power restrictions.

37. Other definitions are inherently contradictory and should be revisited. For example, Subsection 15.503(h) defines wall imaging systems, which are field disturbance sensors use for the purpose of detecting the location of objects contained in a wall, but excludes “stud finders” for construction purposes. This classification makes no sense unless it can include stud finding functions of wall scanners. This matter is better dealt with by reference to “Building Material Analysis” (BMA) addressed in ETSI EN 30 065-4 which takes into account interference

potential of radiated emissions behind the wall being measured. By contrast, Subsection 15.503(j) addresses through-wall imaging systems intended to detect persons or objects behind a wall. Currently this use-case is very specifically limited to governmental uses, such as those of first responders. It is not a regulation intended to address industrial or commercial applications of wall imaging systems that might have some residual emission beyond the wall being evaluated.

38. Finally on the subject of definitions of UWB applications, there are doubtless missing use-cases or gaps in the rules which exclude potentially useful applications. Commission UWB rules should be harmonized on a worldwide basis. UWB is a potentially valuable solution for applications currently needing narrowband spectrum but which are disaccommodated by the absence of an efficient narrowband spectrum sharing mechanism. CEPT/ECC studies accommodate additional UWB applications that the Commission's rules do not, such as operation of UWB devices inside vehicles; fixed outdoor applications for surveillance; generic material sensing; and location tracking systems.¹³

(c) Section 15.509, Technical Requirements for Ground Penetrating Radars and Wall Imaging Systems and Section 15.510, Technical Requirements for Through D-wall Imaging Systems.

39. The problem with Section 15.509 as currently stated¹⁴ is that it artificially limits user groups. Subsection (b) of the rule limits the users of GPRs and wall imaging system users to law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction purposes. While the term "construction" is capable of a reasonably broad interpretation, a large user group are various professionals, such as land surveyors, construction

¹³ These systems are addressed at Section 15.250 of the Commission's rules dealing with wideband devices, but currently there is no tracking possibility in the lower range (3 -4 GHz).

¹⁴ Another issue with this rule section is the requirement of a manual switch for a GPR device that is designed to be operated while being hand held and a wall imaging system. The rule calls for a manually operated switch that causes the transmitter to cease operation within 10 seconds of being released by the operator. This requirement is overly specific. On/off switching can be based on ground and wall contact which can be governed by "movement sensors." GPR devices very often have wheels providing information for signal processing. Others use other types of wall detection sensors, such as inductive sensors, light sensors, or other RF-emissions. More flexibility is called for.

workers, handymen and plumbers. It is understood that the Commission has in the past wanted to exclude UWB consumer products, but there are those who have reasonable individual applications for such devices and the continuation of the total ban on consumer product UWB devices should be re-evaluated due to the exceptionally low interference potential.

40. The same concerns exist with respect to Section 15.510. Part of the eligibility problems set forth in Section 15.510(b) results from the definition in Section 15.503(h) discussed above. Although a through wall imaging system is a field disturbance sensor that is specifically “designed to detect the location of objects contained in a wall or other structure,” it is not necessarily the case that every wall or other structure being scanned by the device will in all cases be dense enough and thick enough to absorb all of the signal transmitted by such an imaging system. This absolute requirement is highly exclusionary, if strictly interpreted. Furthermore, that rule section specifically *excludes* devices such as “stud finders” which are designed to locate objects behind gypsum, plaster or similar walls that are not necessarily capable of absorbing the entire transmitted UWB signal. Because of this, the regulations applicable to “wall imaging systems” do not apply to most such devices including all stud finders, though its intended application may be quite clearly consistent with and in fact identical to FCC-defined “wall imaging systems.”¹⁵

41. Instead, most wall scanning devices are properly defined for United States regulatory purposes as “through-wall imaging systems” as per Section 15.503(i), even though that category of devices was apparently intended to apply largely to a very different type of product. The devices intended to be included in this definition are field disturbance sensors intended to detect

¹⁵ This is an anomaly, because the definition in the rules specifically is intended in general to *include* devices. The rules applicable to UWB wall imaging systems include among authorized users those associated with law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction. See, Section 15.509(b) and the discussion *supra*.

the movement of persons or objects located on the other side of an opaque structure such as a wall or ceiling. However, anomalously, the Commission's UWB rules specifically include in the definition of *through-wall devices* (apparently out of an abundance of caution to insure conservatively that there would not be interference to licensed radio services occupying the same spectrum as the device) "stud finder" type devices which are "designed to locate objects behind gypsum, plaster or similar walls that are not thick enough or dense enough to absorb the transmitted signal." While what the Commission refers to as "stud finder" type devices are most likely to be utilized by professionals in the construction trade, the rule governing UWB "through-wall imaging systems," Section 15.510(b), restricts users of through-wall scanning devices to "law enforcement, emergency rescue or firefighting organizations that are under the authority of a local or state government." While these first responders most certainly have uses for UWB through-wall imaging systems, the fact that the definition seems to include devices specifically intended for professionals in the construction trade and which have a great deal of utility in such a capacity, begs for some simple accommodation. Otherwise, the marketing, sale and use of UWB construction equipment is prohibited in the United States regardless of the definitional status of the device, which makes no sense.

42. Because the purpose of Section 15.510(b) (i.e. to prevent interference from UWB devices *ex ante* to licensed terrestrial RF users by limiting deployment of through-wall devices to those having a need for an imaging system to penetrate walls to search for objects) was not intended to proscribe devices that function as wall imaging devices which are needed by small businesses to substantially enhance, expedite and improve construction of buildings in the United States, it is hoped that Commission will revise and combine these rules to accommodate them for the first time.

(d) Section 15.511, Technical Requirements for Surveillance Systems.

43. In this case as well, eligibility limitations are overly conservative. Subsection (b) of this rule section limits the use of fixed surveillance systems to those operated by law enforcement, fire or emergency rescue organizations or by manufacturers licensees, petroleum licensees or power licensees as defined in §90.7 of the Commission's Rules. But there is a strong demand within the "security" industry to use UWB for intrusion alarm systems. The Commission's eligibility limitations preclude any deployment by other than public safety or critical infrastructure entities. Another important application of this technology not now permitted is for air gap monitoring of wireless power transmission of electrical vehicles.

(e) Section 15.517, Technical Requirements for Indoor UWB Systems.

44. Subsection (a) of this section limits operation under the provisions of this section is limited to UWB transmitters employed solely for indoor operation. For some tracking systems and surveillance applications, outdoor usage should be allowed as well. As discussed above, some interference mitigation requirements would reduce the probability of interference to other radio users, such as duty cycle limitations, antenna pattern limits, and possible limitations in the frequency range deployed for outdoor uses.

(f) Section 15.519, Technical Requirements for Hand Held UWB Systems.

45. Subsection (a) of this Section requires that UWB devices operating under the provisions of this section must be hand held and do not employ a fixed infrastructure. The prohibition of communication with a fixed infrastructure is a problem for use of UWB for tracking systems. UWB tracking tags require battery operation. Therefore, the transmissions are very time limited (i.e. they utilize low duty cycles and/or low activity factors). It is appropriate to review such usage with an eye toward allowing such systems where the interference potential is

shown to be negligible. In one configuration for example, the fixed system could be UWB passive, or the fixed outdoor UWB operation is limited by specific requirements.¹⁶

(g) 15.521 Technical requirements applicable to all UWB devices.

46. Currently, per subsection (a) of this Section, UWB devices may not be employed for the operation of toys. Furthermore, operation onboard an aircraft, a ship or a satellite is prohibited. It is now time that the Commission evaluated the applications of UWB technology, including those for ground-based vehicles within or aboard trains, ships, and construction vehicles. Such applications could be regulated similarly to indoor applications and interference potential could be limited by means of external field strength limits or other mitigation measures.¹⁷ While Bosch makes no suggestion with respect to the use of UWB aboard drones or other aeronautical mobile devices, there is in the ECC/EC a specific regulation in place addressing the use of UWB onboard aircraft.¹⁸

47. Subsection (c) of this rule section states as follows:

(c) Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in §15.209, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in §15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of this part.

¹⁶ See, specifically, ETSI EN 302 065-2: "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 2: Requirements for UWB location tracking".

¹⁷ See, ETSI EN 302 065-3: "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 3: Requirements for UWB devices for ground based vehicular applications".

¹⁸ See, ETSI EN 302 065-5: "Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 5: Devices using UWB technology onboard aircraft".

This requirement is a major problem for UWB devices and the harmonization process worldwide. UWB limits are below the EMC limit ($>10\text{dB}$). This precludes use of UWB transmit or receive devices being embedded into another device. If the combined device is regulated by some other transmit or receive requirements, or uses a display or contains other digital circuits, the emissions from these parts could be higher than the UWB emissions and for the test it is not possible to differentiate between or to separate the emissions. To address this, ETSI developed a test procedure to permit a means to differentiate between the emissions. See, EN 303 883. It would be helpful if the Commission were to address this problem in the revision of the Subpart F rules.

48. The latter portion of Subsection (d) of this rule requires "... a resolution bandwidth of 1 MHz, an RMS detector, and a 1 millisecond or less averaging time. Unless otherwise stated, if pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements shall be made with the pulse train gated on. Alternative measurement procedures may be considered by the Commission." In general, this requirement is not problematic, but Bosch would note that many UWB signals are no longer pulsed based and therefore the differences in the emission types and signal characteristics should be reflected in the tests. The same problem exists in Subsection (g) addressing peak measurement resolution bandwidth. ETSI EN 303 883 proposes a signal dependent solution to avoid errors in evaluating the peak power level. The calculation called for by Subsection (g) is correct for pulsed based systems but it could lead to problems for other kinds of UWB signals.

IV. Conclusions.

49. The Public Notice in this proceeding proposes to review some, but not all of the UWB rules, all of which were adopted in the 2002 First Report and Order in an admittedly

contentious docket proceeding. It is unclear why only a subset of these rules is now under consideration for revision or deletion. It makes no sense at all to review some but not all of the fifteen-year-old rules governing ultra-wideband operation, several of which impose substantial limitations on small business entities, both manufacturers and user groups which are disaccommodated by the overly restrictive UWB rules. The Commission should revisit and modify the rules set forth hereinabove, most especially the definitional requirement for minimum bandwidth determination, in order to promote harmonized rules worldwide.

Therefore, the foregoing considered, Robert Bosch, LLC respectfully requests that the Commission review and modify the UWB rules under Part 15, Subpart F as set forth herein.

Respectfully submitted,

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